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Ar. 1829.

THE NEW
SPIRIT CALCULATOR;

CONTAINING

Rules and Examples

Comprehending all possible cases for

REDUCING AND COMPOUNDING SPIRITS,

FROM

ANY GIVEN TO ANY REQUIRED STRENGTH;

INCLUDING

AN USEFUL RULE,

NEVER HITHERTO PUBLISHED,

FOR RAISING THE DEGREE OF STRENGTH OF SPIRITS;

ALSO,

Original Tables,

BY WHICH

ANY QUANTITY OF SPIRITS MAY BE REDUCED FROM ANY GIVEN
TO ANY REQUIRED STRENGTH,

From 30 per Cent. above, to 55 per Cent. below Hydrometer proof;

A CHEMICAL AND PRACTICAL SKETCH OF THE

PROCESS OF DISTILLATION,

WITH SOME

LAW EXTRACTS, GENERAL ORDERS, DIRECTIONS & OBSERVATIONS

OF IMPORTANCE TO

Brandy Dealers and Officers.

BY E. ARTHUR, OFFICER OF EXCISE.

WORCESTER:
PRINTED AND SOLD FOR THE AUTHOR,
BY T. EATON, COLLEGE STREET;
Sold also by
LONGMAN, REES, ORME, BROWN, & GREEN, LONDON.
1829.

7.

ENTERED AT STATIONERS' HALL.

BIBLIOTHECA · BODLEIANA ·

TO MR. E. ARTHUR.

SIR,

I have examined the manuscript of your "NEW SPIRIT CALCULATOR," and consider it a useful Compendium of Practical Rules and Tables for calculating the strength of Spirits, whereby the subject is clearly opened, and the title page is fully made out in the course of the work. It will therefore be a valuable acquisition to Brandy Dealers and Officers.

WM. TOWNSHEND,
GENERAL SURVEYOR.

No. 8, WALWORTH PLACE,
LONDON,
February 4th, 1829.

PREFACE.

THE stock of every *Distiller, Rectifier*, or *Compounder* of and *Dealer* in Spirits, being now calculated, and the account thereof kept in gallons at proof, it becomes an important part of the business of every such trader, and of every Officer of Excise, who has or may have any such traders under his survey, to know how to reduce spirits of any given to any required strength. And it is presumed that the following pages contain rules comprehending all possible cases, and that they are illustrated by familiar and practical examples and observations; whereby such information is afforded that will secure traders from penalties and losses, and officers from embarrassment and confusion in this important part of their duty.

I have introduced an original, plain, and useful rule, for raising the strength of spirits by the introduction of spirits of a higher degree of strength; for which no arithmetical rule has hitherto been published, therefore such questions could only be answered methodically, by Algebra,

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Collections.	*Collectors' Residences.*	*Collectors' Names.*
Barum	Barnstaple	Charles Inston
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Bedford	Hitchen	Thomas Woodford
Bristol	Bristol	John Nightingale
Cambridge	Cambridge	Charles Popple
Canterbury	Dover	Francis Brothers
Chester	Chester	Thomas Ward
Cornwall	Falmouth	John White
Coventry	Coventry	John Tanfield
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Durham	Sunderland	Gabriel Rawlings
Essex	Colchester	Robert Latten
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Hull	Hull	William Cramp
Isle of Wight	Southampton	William Saunders
Lancaster	Lancaster	John Cookson
Leeds	Leeds	Jesse Woodward
Lichfield	Birmingham	John Ombler
Lincoln	Lincoln	Thomas Rayner
Liverpool	Liverpool	Joseph Simpson
Lynn	Lynn	John Brown
Manchester	Manchester	Thomas Graham
Marlborough	Marlborough	Joseph Andrews
Newcastle	Newcastle	Robert Coulson
Northampton	Northampton	Thomas Bushby
Northumberland	Alnwick	Evan Evans
Northwich	Northwich	William Jackson
Norwich	Yarmouth	Francis Parker
Oxford	Oxford	Thomas Beard
Plymouth	Plymouth	Gustavus Gidley
Reading	Reading	Thomas Richards
Rochester	Rochester	James Pearson
Sarum	Salisbury	William Bruorton
Salop	Shrewsbury	John Pratt
Sheffield	Sheffield	Joseph Thompson
Somerset	Wells	George Wood
Stafford	Stafford	Richard Evans
Stourbridge	Stourbridge	John Couch
Suffolk	Ipswich	James Cardew
Surrey	Brentford	Nath. Woodruffe
Sussex	Sussex	William Lambert
Uxbridge	Amersham	William Allen
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Wales, Middle	Welshpool	John Sykes
Wales, North	Carnarvon	William Jackson
Wales, West	Carmarthen	Benjamin Grisdale
Wellington	Wellington	Cuthbert Rodham
Whitby	Whitby	James Bridgwater
Wigan	Wigan	George Lewis
Worcester	Worcester	John Fox
York	York	Thomas Hall

CHEMICAL OBSERVATIONS.

The basis of all spirit is alcohol, which is mixed with water in sundry proportions, and British spirits are charged with duty in proportion to the quantity of proof spirit which they contain. This is estimated by the specific gravity of the spirits, (the hydrometer being the legal instrument for ascertaining the gravity); but proof spirits are defined by law to be such spirits as shall weigh $\frac{12}{13}$ of the weight of distilled water, at the temperature of fifty-one degrees by Fahrenheit's thermometer.

THE PROCESS OF DISTILLATION.

Alcohol is obtained by mixing malt or grain, which has been ground or bruised, with hot water; or it may be extracted from sugar or potatoes. After the ingredients have been properly mixed or mashed, the infusion is left at rest for some time, during which the saccharine matter is extracted by the water from the malt or grain, &c.; the liquid is then drawn off, more water is added, and the infusion is repeated till the strength of the malt or grain is sufficiently extracted.

The worts thus obtained are pumped into coolers, or cooled in pipes immersed in water, and when sufficiently cold are conveyed into vats. Yeast is afterwards added, to induce fermentation, which is carried as far as possible.

As soon as the process of fermentation commences, the saccharine matter contained in the wort is gradually converted into spirits, and the wash is attenuated or rendered more light, in proportion to the decomposition of the saccharine matter, and the development of the spirit it contains.

The wash thus prepared is conveyed to the wash-still, where it is made to boil, and the spirituous parts rise in vapour, which is condensed in the worm or alembick, (the worm being kept cool for the purpose, by being surrounded with cold water in the worm-tub, and making many convolutions therein.) Here the vapours are condensed, and what entered the pipe in fume comes out in drops.

Low wines are spirits of the first distillation from the wash; are generally weak and impure, requiring to be redistilled ere they become fit for consumption. The definition given by law is "that all spirits of the first extraction drawn or produced by one distillation of wash, shall be deemed and called low wines."

The low wines are pumped up from the receiver into a charger, and conveyed into the low wines still, and being boiled there, the spirits issuing from the end of the worm are conveyed through the safe into the spirits receiver, the impure parts being conveyed from the safe into the feints receiver, and the feints are subsequently redistilled, until they become sufficiently pure for consumption.

The above sketch of the manufacture of spirits, will afford to the inexperienced an idea of the process of distillation. Thence the spirits are removed for rectification, and are again distilled and compounded, and prepared for consumption by the rectifier.

LAW EXTRACTS.

As the law now stands, no spirits are allowed to be sent out of the stock of any Distiller, at any other strength than 25 *per centum*, or eleven *per centum* above, or ten *per centum* below hydrometer proof; but by general order of Sept. 19th, 1828, an indulgence is granted which allows a variation of six-tenths of a gallon *per cent.* upon spirits warehoused. (6 Geo. 4, chap. 80, sec. 81.)

Denomination of Spirits.

All spirits distilled in England, or distilled in Scotland or Ireland, and imported into England, are deemed by law British spirits. And all spirits which have not had any flavour communicated thereto, are called Plain British Spirits; and all other spirits produced by redistillation, and which shall have had any flavour communicated thereto, are deemed a British compound, called British Brandy; and all other spirits which shall have been distilled or mixed with juniper-berries, carrawayseeds, anniseeds, or any other seeds, preparation, or ingredient, whatsoever, used in the compounding of spirits, are called British Compounds.
(6 Geo. 4, chap. 80, sec. 101.)

All British spirits of the strength of 43 *per cent.* above proof, or upwards, are called Spirits of Wine. And every dealer in, and retailer of spirits, shall keep all spirits of wine in a separate and distinct cellar, or place specially entered for that purpose, in which no other spirits or foreign wine, or sweets, are or shall be kept.
(6 Geo. 4, chap. 80, sec. 114.)

No dealer in spirits is allowed to send out above 100 gallons of spirits of wine to any one person in the same day. (Sec. 125.)

Strength of Spirits.

No dealer in British spirits shall sell or receive or keep in his stock any plain British spirits, except spirits of wine, of any strength exceeding 25 *per cent.* above, or of any strength below 17 *per cent.* under hydrometer proof.

(6 Geo. 4, chap. 80, sec. 124.)

No retailer of spirits shall sell or receive or keep in stock any spirits of wine exceeding at one time ten gallons, or any plain British spirits of any strength exceeding 25 *per cent.* above, or lower than 17 *per cent.* under proof, or any compounded British spirits not being shrub, of any greater strength than 17 *per cent.* under proof; or any foreign or colonial spirits (not being compounded colonial spirits) of any less strength than 17 *per cent.* under proof.

(6 Geo. 4, chap. 80, sec. 130.)

Spirits to be kept separate.

Every dealer in foreign and British spirits shall keep the same separate and apart, in separate cellars, vaults, or other places specially entered for that purpose respectively. And no person shall mix or keep, sell or send out, any British spirits mixed with foreign or colonial spirits. But every dealer in and retailer of spirits shall be allowed on all foreign or colonial spirits (not being compounded colonial spirits) lawfully brought into stock, *additional* credit for such further number of gallons of water, added to such spirits in the presence of the officer, as shall be necessary to reduce the strength thereof to 17 *per cent.* under proof.

(6 Geo. 4, chap. 80, sec. 126.)

Spirits Permitted.

No distiller, rectifier, or compounder of, or dealer in, or retailer of spirits, shall be allowed to take out more than one permit in one day for the same person, and that only for one cask or other package (not being bottles) containing any spirits of one sort or kind; but any seller of spirits is allowed to request two or more permits, and by virtue thereof to send out two or more casks or other packages containing spirits of a different sort or kind, to the same

person in the same day, so as each cask or package respectively shall be separately and distinctly described in such permit or permits: and also with one and the same permit any number of casks, with any kind of spirits therein, each such cask then containing 80 gallons or upwards of spirits.
(6 Geo. 4, chap. 80, sec. 127.)

And by general order of Feb. 6th, 1826, It is also ordered that no objections be made to granting a permit for more than one cask of British compounds, of less content than 80 gallons, provided the spirits in each cask differ either in quality, or strength, and each kind be distinguished by the name under which it is generally known in trade, and the strength of each be particularized in the request note.

The Common Arithmetical Signs which are used in this Work for the sake of brevity, are explained hereunder.

$+$ Addition. Thus $5+3$ signify that 5 and 3 are added.
$-$ Subtraction. $5-3$, that 3 are to be deducted from 5.
$\times$ Multiplication. 5×3, that 5 are to be multiplied by 3.
$\div$ Division. $5\div3$, that 5 are to be divided by 3.
$=$ Equality. $5+3=8$, that 5 and 3 are equal to 8.
$5\times3+3-2\div8=2$, that 5 times 3, and 3, less 2, divided by 8, are equal to 2.
$3:5::9:15$ Proportion. As 3 are to 5, so are 9 to 15. Here multiply second and third terms, and divide by the first: thus $5\times9=45\div3=15$.
$\sqrt{144}$. Evolution or the square root of such number is to be extracted; thus $\sqrt{144}=12$.

$\sqrt[3]{1728}$. Evolution or the cube root of such number is to be extracted thus: $\sqrt[3]{1728}=12$.

$\overline{12|}^{2}$ or $\overline{12|}^{3}$ Involution; that is, the square or cube of such numbers are required.

$\frac{144}{12}=12$. Division; that is, $144\div12=12$.

REDUCTION OF SPIRITS

FROM ANY GIVEN TO ANY REQUIRED STRENGTH.

PROPOSITION I.

When Spirits are required to be reduced to proof.

CASE I. *When the strength is given in bulk, as it is generally practised at the ports.*

RULE. If the strength be over proof, add the given strength to the given quantity.

Or, if the strength be under proof, deduct the given strength from the given quantity, and the sum or difference will be the number of gallons at proof.

EXAMPLE 1. Suppose 115 of rum be permitted, and 25 gallons over proof?

* Then 115+25=140 at proof.

Ex. 2. Suppose 115 gallons of brandy be permitted, and 2 gallons under proof?

Then 115—2=113 at proof.

This case being so easy, more examples would be useless.

---

* The strength of spirits is now calculated at so much *per centum* over or under proof.

Case II. *When the strength is designated by its proportion per centum.*

Rule. If the strength be overproof, multiply the given strength with 100, added thereto by the given quantity, and point off two figures for decimals, which is the same as dividing by 100.

Or, if the strength be under proof, take the difference between 100 and the given strength, and multiply the given quantity thereby, and point off two figures for decimals, and the product will be the number of proof gallons required.

Or 2. Make the difference between 100 and the given strength a factor of two places of decimals, and multiply the given quantity thereby, and the product will be the answer in gallons at proof.

Ex. 1. Suppose 84 gallons to be 18 per cent. O. P. what quantity of water will reduce the same to proof?

Here 118=given strength, with 100 added.
84
472
944
99.12=gallons at proof.

And 99·12—84=15·12 the water required.

Ex. 2. Suppose 55 gallons to be 15·5 per cent. overproof, how many gallons will it be at proof?

Here 115·5 the given strength, with 100 added.
55 the given quantity.
5775
5775
63·525 proof gallons required.

By Rule 2.

```
1·155 the given strength made a factor
   55
 ─────
 5775
5775
 ─────
63·525 gallons as above.
```

By Proportion, say

As unity is to the given quantity, so is the given strength to the quantity required.

As 1 : 55 : : 1·155 : 63·525 by Rule 2.

Or, As 100 : 55 : : 115·5 : 63·525 by Rule 1.

By the Sliding Rule.

	on B		on A		on A		on B
Set	55	to	100	and against	115	will be	63·5
	Given quantity.		or unity.		Given strength.		Proof gallons.

And 63·5—55=8·5 gallons of water necessary to reduce the above to proof.

Ex. 3. Suppose 71 gallons of compounds to be 33·0 per cent. U. P. what quantity of proof spirits are contained therein?

Here 100—33=67 the difference between 100 and the given strength. And 67×71=47·57 gallons at proof.

The same by Proportion.

As 100 : 71 : : 100—33=67 : 47·57 by Rule 1.

Or, As 1 : 71 : : ·67 : 47·57 by Rule 2.

By the Sliding Rule.

	on B		on A		on A		on B
Set	71	to	100	and against	67	will be	47·57
	Given quantity.		or unity.		Given strength.[*]		Proof gallons.

---

[*] For the sake of brevity, the per centage, with 100 added, is called the strength in over proof, and the difference

Ex. 4. Suppose 6⅛ gallons to be 55·0 per cent. under proof, how much proof spirits are contained therein?

The above, or any other similar question, must be first reduced from vulgar to its equivalent decimal fractions, by adding ciphers to the numerator and dividing by the denominator.

Thus ½ is 2)1·0 and ¼ is 4)1·00 and ¾ 4)3·00
·5 ·25 ·75

⅛ is 8)1·000 and $\frac{1}{16}$ will be 1·0000÷16=·0625
·125

So then the above question expressed decimally will be 6·125 gallons.

Here 6·125×45=2·75625 gallons at proof.

Or, As 100 : 6·125 : : 45 : 2·75625 gallons.

By the Sliding Rule.

	on B		on A		on A		on B
Set	6·125	to	100	and against	45	will be	2·75
	Given quantity.		or unity.		Given strength.		Required quantity.

PROPOSITION II.

When spirits of a given strength are required to be reduced to any other strength, and no additional spirits introduced.

Case I. ***When a given and required strength and a given quantity are proposed to find an unknown or required quantity.***

---

between 100 and the per centage is called the strength in under proof spirits.

RULE. As the strength sought is to the given quantity, so is the given strength to the quantity required.

N. B. Reference must be had to the rules under Proposition 1, as whether the strength be expressed in bulk or per centum. And if in bulk, it may be reduced to its equivalent per centage by proportion; for as the quantity is to the strength, so is 100 to the per centage.

Suppose 84 gallons, 24 over proof.

Here, as 84 : 24 : : 100 : 28·57 per centum.

Suppose 80 gallons, 24 over proof.

Here, as 80 : 24 : : 100 : 30 per centum over proof.

Ex. 3. Suppose 91 gallons of rum, and 30 gallons over proof, be required to be reduced to 12·6 under proof, how much water will it require?

Here, as 91 : 30 : : 100 : 33·0 per cent. over proof.

	Strength sought.		Given quantity.		Given strength.		Quantity required.
Then, as	100—12·6=87·4	:	91	: :	133	:	138·4

And 138·4—91=47·4 the water required.

Or the above question may be wrought thus:

91 the given quantity.
30 the gallons O. P.; so much water added.

121 gallons at proof.

	Proof spirits.		Water.		Proof spirits.		Water.
Then, as	87·4	:	12·6	: :	121	:	17·4 in addition

to 30 gallons used to reduce the spirits to proof.

Hence 30+17·4=47·4 water as above.

By the Sliding Rule.

	on B		on A		on A		on B
Set	91	to	87·4	and against	133	will be	138·4

Or when the given quantity has been first reduced to proof,

on B on A on A on B
Set 12·6 to 87·4 and against 121 will be 17·4

Ex. 4. Suppose 108 gallons of brandy to be 05·5 per cent. O. P. how much water will be necessary to reduce it to 14·0 per cent. U. P.

	Strength sought.		Given quantity.		Given strength.		Quantity required.
Here 100—14=	86	:	108	: :	105·5	:	132·5 gall.

And 132·5—108=24·5 the water required.

This question also may be performed by two operations both by pen and rule, which proves the work; that is, first reduce the given quantity to proof, and then reduce it to the strength required.

As 100 : 108 : : 105·5 : 113·94 gallons.

And 113·94—108=5·94 water to reduce it to proof.

Then, as 86 : 14 : : 114 : 18·56 further quantity of water.
5·94 these added.

Total quantity 24·5 as above.

N. B. The natural reciprocation of these questions is *Inverse,* and I at first intended that they should stand in that order; but knowing that Direct Proportion is much more familiar to persons in general than Inverse Proportion, I therefore transposed the first and third terms, so that they all now stand in Direct Proportion.

The preceding question performed by the Sliding Rule.

First, by one operation.

on B on A on A on B
Set 108 to 86 and against 105·5 will be 132·5
Given quantity. Strength sought. Given strength. Required quantity.

And 132·5—108=24·5 the water required.

Second, by two operations.

on B on A on A on B
Set 108 to 100 and against 105·5 will be 114 nearly.

And 114—108=6 gallons, the water to reduce it to proof.

on B on A on A on B
Then set 14 to 86 and against 114 will be 18·5 and a little above.

And the quantity (18·5) thus found, in addition to the
6 gallons previously added,

Gives 24·5 of water, as above.

At the request of a gentleman, I here give a few examples worked at full length, as this case will be more practically useful to brandy dealers than any other.

Ex. 5. Suppose 112 gallons of brandy, 0·5 per cent. over proof, is to be reduced to 13 per cent. under proof; how much water will be required?

Strength required.	Given quantity.	Given strength.	Required quantity.
100—13=87 :	112 : :	100·5 :	129·4

100·5
112
2010
1005
1005

87) 11256·0 (129·4 nearly.
87
255
174
816
783
330
348

And 129·4—112=17·4 the water required.
112
17·4

By the Sliding Rule.

on B on A on A on B
Set 112 to 87 and against 100·5 will be 129·4 gallons, the total quantity when reduced to 13 per cent. U. P. And the difference between this quantity and the original quantity, is the quantity of water.

Ex. 6. Suppose 54 gallons of brandy at 02·4 per cent. O. P.; how much water will be necessary to reduce it to 12·5 per cent. U. P.?

Strength sought. Given quantity. Given strength. Required quantity.
Here 100—12·5=87·5 : 54 : : 102·4 : 63·2
54
4096
5120
87·5) 5529·6 (63·2 nearly.
5250
2796
2625
1710
1750

And 63·2 gall. the total quantity when reduced
54=the original quantity.

9·2 gall. water necessary to reduce 54 gall. at 02·4 per cent. O. P. to 12·5 per cent. U. P.

The above by two Operations.

As 100 : 54 : : 102·4 : 55·3 nearly.

And 55·3—54=1·3 water to reduce it to proof.

Then, as 87·5 : 12·5 : : 55·3 : 7·9 further quantity of water, which with 1·3 make
the total quantity 9·2 as above.

Ex. 7. Suppose 45 gall. at 02·5 per cent. under proof, be required to be reduced to 14·5 per cent. under proof; how much water will do this?

Strength required. Given quantity. Given strength. Required quantity.
Here 100—14·5=85·5 : 45 : : 100—2·5=97·5 : 51·3
45
4875
3900
85·5) 4387·5 (51·3
4275
1125
855
2700
2565
135

And 51·3—45=6·3 water, the requisite quantity.

Prove this by reducing the given quantity to proof, and then reduce it to the strength required.

Here 100—02·5=97·5×45=43·9 gall. at proof.

Proof. Water. Proof. Water.
Then, as 85·5 : 14·5 : : 43·9 : 7·4 total quantity.

And 45—43·9=1·1 water in the given quantity.

Again 7·4—1·1=6·3 water required, as above.

By the Sliding Rule.

on B on A on A on B
Set 45 to 85·5 and against 97·5 will be 51·3;

and 51·3—45=6·3 gall. of water, as above.

Ex. 8. Suppose 80 gallons of British compounds be 22·0 per cent. under proof, how much water will be necessary to reduce the same to 42·0 per cent. under proof?

	Required strength.		Given quantity.		Given strength.		Required quantity.
Here	100—42=58	:	80	: :	100—22=78	:	107·6
					80		

58) 6240 (107·6 nearly.
58
440
406
340
348

And 107·6=the total quantity when reduced.
80 =the original quantity.
27·6=the requisite quantity of water.

Or reduce the given quantity to proof, and then reduce it to the strength required, as under:

100—22=78 × 80=62·4 gallons at proof.

	Proof.		Water.		Proof.		Water.
Then	58	:	42	: :	62·4	:	45·2 total quantity.

And 80—62·4=17·6 water in the given quantity.

Also, 45·2—17·6=27·6 water, as above.

By the Sliding Rule.

	on B		on A		on A		on B
Set	80	to	58	and against	78	will be	107·6;

and 107·6—80=27·6 gallons of water, as before.

Ex. 9. Suppose 71 gallons of British compounds to be 33·0 per cent. under proof, how much water will reduce the same to 55·0 per cent. under proof?

	Strength required.	Given quantity.		Given strength.	Required quantity.
Here	100—55=45 :	71	: :	100—33=67 :	105·7

71

67

469

45) 47·57 (105·7

45

257

225

320

315

5

And 105·7—71=34·7 gallons, the water required.

Prove the above by reducing the given quantity to proof, and then reduce it to the strength required.

Thus 100—33=67

71 the given quantity.

67

469

47·57 gallons at proof.

	Proof.	Water.		Proof.	Water.
Then	45 :	55	: :	47·57 :	58·1

55

23785

23785

45) 2616·35 (58·1 total quantity of water.

225

366

360

60

And 71—47·57=23·43 water contained in the given quantity.

Also 58·1—23·43=34·67 gallons of water, as above.

By the Sliding Rule.

The first Method.

	on B		on A		on A		
Set	71	to	45	and against	67	will be	105·7

The Second Method.

	on B		on A				on B
Set	71	to	100	and against	67	will be	47·6

	on B		on A		on A		on B	
Then set	55	to	45	and against	47·6	will be	58·1	total quan.
	Water.		Proof.		Proof.		Water.	

Any of the preceding questions may be put *vice versa*, and answered by the same rule.

Ex. 3, put *vice versa*. How many gallons of rum, 33·0 per cent. over proof, may I have in exchange for 138·4 at 12·6 per cent. under proof?

	Strength required.		Given quantity.		Given strength.		Required quantity.
Here	133	:	138·4	: :	87·4	:	91

This answer is a little deficient, because 133 or 33·0 per cent. is a little too much as an equivalent for 30 gallons in bulk.

Ex. 4, *vice versa*. How many gallons of brandy, 05·5 per cent. over proof, may I have in exchange for 132·5 gall. at 14·0 per cent. under proof?

	Strength required.		Given quantity.		Given strength.		Required quantity.
Here	105·5	:	132·5	: :	100—14=86	:	108 gall.

at 05·5 over proof.

By this *Rule* may be ascertained any required proportions of spirits and water, when the given quantity is to be kept the same, and the degree of strength raised by redistillation.

Ex. 10. A distiller has 100 gallons of spirits which run off 25·0 per cent. under proof, and he wishes to distil it over again to raise the strength to 20·0 per cent. over proof; how much water will remain in the still, and how much spirits will run off at the desired strength?

	Required strength.		Given quantity.		Given strength.		Required quantity.
Here	120	:	100	: :	100—25=75	:	62·5 spirits.

100

120) 7500 (62·5 spirits.
720 37·5 water.

300 100
240

600
600

For 100—25=75 gallons at proof.

And 62·5 × 120=75 gallons at proof.

Ex. 11. Suppose 100 gallons, 10 per cent. under proof, be required to be raised to 20 per cent. over proof, by redistillation; what will be the quantity of spirits?

	Strength required.		Given quantity.		Given strength.		Required quantity.
Here	120	:	100	: :	90	:	75 gallons of spirits.
			And consequently				25 gallons of water.
							100

Ex. 12. Suppose 40 gallons of plain British spirits, 25·0 per cent. over proof, be mixed with 120 gallons at 17·0 per cent. under proof; what will be the strength thereof?

Here 125
40

50·00 at proof.

And 83
120

99·60 at proof.
50

149·6 total at proof.

Then 40+120=160 : 100 :: 149·6 : 93·5
100

160) 14960·0 (93·5
1440

560
480

800
800

And 100—93·5=6·5 per cent. under proof. *Answer.*

Ex. 13. The same quantities as above, with the strengths thereof transposed; viz. 40 gallons at 17·0 per cent. under proof, and 120 gallons at 25·0 per cent. over proof.

Here 40 × 83= 33·2 } Gallons at proof.
And 120 × 125=150 }

183·2

And 40+120=160 : 100 :: 183·2 : 114·5
100

160) 18320·0 (114·5
160 100

232 14·5 per cent. O. P.
160

720
640

800
800

Case II. *When the given and the required quantity and strength are given to find an unknown or required strength.*

Rule. As the quantity required is to the given strength, so is the given quantity to the unknown or required strength.

N. B. By this Rule the strength of shrub, or any other compounded spirits, may be ascertained.

Ex. 1. Suppose 24 gallons of rum at 12·6 per cent. under proof, to be made into 50 gallons of shrub; what will be the strength thereof?

	Quantity required.		Given strength.		Given quantity.		Required strength.
Here	50	:	100—12·6=87·4	: :	24	:	42 nearly.

And 100—42=58 per cent. the strength required.

By the Sliding Rule.

	on B		on A		on A		on B
Set	87·4	to	50	and against	24	will be	42 nearly.
	Given strength.		Required quantity.		Given quantity.		Strength required.

Ex. 2. Suppose 13 gallons of rum, 25·0 per cent. over proof, to be made into 40 gallons of shrub; what will be the strength of the same?

	Quantity required.		Given strength.		Given quantity.		Strength sought.
Here	40	:	125	: :	13	:	40·6

And 100—40·6=59·4 per cent. the strength required.

By the Sliding Rule.

on B on A on A on B
Set 125 to 40 and against 13 will be 40·6; which deducted from 100, will shew the per centage.

To prove the work, reduce the spirits previous to their being compounded, and the shrub after it has been compounded, to proof; and if the number of gallons be the same, the work is right.

The above question proved.

	Rum		Shrub
125·0 strength.		40·6 strength.	
13 quantity.		40 quantity.	
375		16·240 gallons at proof.	
125			
16·25 gallons at proof.			

By general letter of 27th Feb. 1826, dealers in and retailers of foreign spirits are allowed to make shrub, upon their giving twenty-four hours notice, specifying the quantity, quality, and strength of the spirits to be compounded.

A Precedent for Officers taking account thereof.

	1	Temperature.	Indication.	Strength.	2	Temperature.	Indication.	Strength.
Bung	36·0				25·0			
Content	100				58			
Quality	R.				Rsh			
Nov.	93			op.				
26 ep 1 to	31.2	56°	41·8	25·0	O			
	80				40			u. p.
ep 2	26·4	56°	418	250	16·1	decl^d.		58·0

After the composition is made, the trader must give a written declaration of the quantity and strength of the same; which, if correct, must be marked upon the cask, and permitted out accordingly.

Attended and saw rum from No. 1 made into shrub in No. 2, as per notice.

Insert the date of attendance, the quantity, quality, and strength, in the Survey Book, in the "Brought in place." And in the Ledger deduct the number of proof gallons from the rum, and on the next line below insert the date, quantity, quality, and strength of the shrub; the quantity at proof will be the same that was deducted from the rum which insert in the column for Rsh.

N. B. The above survey is correctly reduced and proved in the preceding example.

Ex. 3. Suppose 220 gallons of British compounds, at 22·0 per cent. under proof, and 96 gallons at 60 per cent. under proof, are to be mixed together, what will be the strength of the mixture?

Here 220×78=171·6 proof gallons.
And 96×40= 38·4 proof gallons.
210· total at proof.

Again 220+96=316 : 100 : : 210 : 66·45

And 100—66·45=33·55 per cent. the required strength of the mixture.

By the Sliding Rule.

on B on A on A on B
Set 220 to 100 and against 78 will be 171·6 proof.
Again 96 to 100 and against 40 will be 38·4 proof.
316 Total 210· proof.

on B on A on A on B
Set 316 to 100, and against 210 will be 66·45;

and 100—66·45=33·55 the required strength.

UNDER the principal of the foregoing *Rules* I have constructed a set of

ORIGINAL TABLES,

for the use and convenience of Brandy Dealers and Officers, by which may be found the requisite number of gallons of water to reduce any quantity of Spirits from any given to any required strength, from 30 per cent. above to 55 per cent. below hydrometer proof.

TABLE 1.—Shewing the requisite Quantity of Water to reduc
from 30 per c

Gall. of Spirits.	PER											
	30	29	28	27	26	25	24	23	22	21	20	19	18
1	·3	·3	·3	·3	·3	·3	·2	·2	·2	·2	·2	·2	·2
2	·6	·6	·6	·5	·5	·5	·5	·5	·4	·4	·4	·4	·4
3	·9	·9	·8	·8	·8	·7	·7	·7	·7	·6	·6	·6	·5
4	1·2	1·2	1·1	1·1	1·0	1·0	1·0	·9	·9	·8	·8	·8	·7
5	1·5	1·4	1·4	1·3	1·3	1·3	1·2	1·2	1·1	1·0	1·0	·9	·9
6	1·8	1·7	1·7	1·6	1·6	1·5	1·4	1·4	1·3	1·3	1·2	1·1	1·1
7	2·1	2·0	2·0	1·9	1·8	1·8	1·7	1·7	1·6	1·5	1·4	1·3	1·3
8	2·4	2·3	2·2	2·2	2·1	2·0	1·9	1·8	1·8	1·7	1·6	1·5	1·4
9	2·7	2·6	2·5	2·4	2·3	2·2	2·1	2·0	2·0	1·9	1·8	1·7	1·6
10	3·0	2·9	2·8	2·7	2·6	2·5	2·4	2·3	2·2	2·1	2·0	1·9	1·8
20	6·0	5·8	5·6	5·4	5·2	5·0	4·8	4·6	4·4	4·2	4·0	3·8	3·6
30	9·0	8·7	8·4	8·1	7·8	7·5	7·2	6·9	6·6	6·3	6·0	5·7	5·4
40	12·0	11·6	11·2	10·8	10·4	10·0	9·6	9·2	8·8	8·4	8·0	7·6	7·2
50	15·0	14·5	14·0	13·5	13·0	12·5	12·0	11·5	11·0	10·5	10·0	9·5	9·0
60	18·0	17·4	16·8	16·2	15·6	15·0	14·4	13·8	13·2	12·6	12·0	11·4	10·8
70	21·0	20·3	19·6	18·9	18·2	17·5	16·8	16·1	15·4	14·7	14·0	13·3	12·6
80	24·0	23·2	22·4	21·6	20·8	20·0	19·2	18·4	17·6	16·8	16·0	15·2	14·4
90	27·0	26·1	25·2	24·3	23·4	22·5	21·6	20·7	19·8	18·9	18·0	17·1	16·2
100	30	29	28	27	26	25	24	23	22	21	20	19	18
200	60	58	56	54	52	50	48	46	44	42	40	38	36
300	90	87	84	81	78	75	72	69	66	63	60	57	54
400	120	116	112	108	104	100	96	92	88	84	80	76	72
500	150	145	140	135	130	125	120	115	110	105	100	95	90
600	180	174	168	162	156	150	144	138	132	126	120	114	10
700	210	203	196	189	182	175	168	161	154	147	140	133	12
800	240	232	224	216	208	200	192	184	176	168	160	152	14
900	270	261	252	243	234	225	216	207	198	189	180	171	16
1000	300	290	280	270	260	250	240	230	220	210	200	190	1

This Table is constructed agreeably to the principle of P

The Use of the Table.—Suppose Example 1, on page 18, the marginal column on the left for 80, and under 18 at the t

o reduce *to pr*
30 per cent. ove

PER CENT. O				
9	18	17	16	
·2	·2	·2	·2	
·4	·4	·3	·3	
·6	·5	·5	·5	
·8	·7	·7	·6	
·9	·9	·8	·8	
11	1·1	1·0	1·0	
13	1·3	1·2	1·1	
15	1·4	1·4	1·3	
17	1·6	1·5	1·4	
19	1·8	1·7	1·6	
38	3·6	3·4	3·2	
57	5·4	5·1	4·8	
76	7·2	6·8	6·4	
95	9·0	8·5	8·0	
4	10·8	10·2	9·6	
3	12·6	11·9	11·2	1
2	14·4	13·6	12·8	1
1	16·2	15·3	14·4	1
[illegible]	18	17	16	1
[illegible]	36	34	32	3
[illegible]	54	51	48	4
[illegible]	72	68	64	6
[illegible]	90	85	80	7
[illegible]	108	102	96	9
[illegible]	126	119	112	1
[illegible]	144	136	128	1
[illegible]	162	153	144	1
[illegible]	180	170	160	1

Proposition 1, a
18, wherein 84 ga
top stands 14·4,

TABLE 2.—Shewing the requisite quantity of Water to red any strength from proof to 17 per cent. under proof, t under proof.

Gallons 100		PER CENT. UND								
		1	2	3	4	5	6	7	8	9
	Proof	1	2	3·1	4·2	5·3	6·4	7·5	8·7	9·9
1 per ct.	U.P.	0	1	2·1	3·2	4·3	5·3	6·4	7·6	8·8
2 ——	——	..	0	1	2·1	3·2	4·3	5·3	6·4	7·7
3 ——	——	..	..	0	1	2·1	3·2	4·2	5·3	6·6
4 ——	——	..	..	..	0	1	2·1	3·1	4·2	5·4
5 ——	——	..	..	..	..	0	1	2	3·1	4·3
6 ——	——	..	..	..	..	..	0	1	2	3·2
7 ——	——	..	..	..	..	..	..	0	1	2·1
8 ——	——	..	..	..	..	..	..	..	0	1
9 ——	——	..	..	..	..	..	..	..	..	0
10 ——	——	..	..	..	..	..	..	..	..	..
11 ——	——	..	..	..	..	..	..	..	..	..
12 ——	——	..	..	..	..	..	..	..	..	..
13 ——	——	..	..	..	..	..	..	..	..	..
14 ——	——	..	..	..	..	..	..	..	..	..
15 ——	——	..	..	..	..	..	..	..	..	..
16 ——	——	..	..	..	..	..	..	..	..	..
17 ——	——	..	..	..	..	..	..	..	..	..

This Table is constructed agreeably to the principle of

Its Use.—Should the given quantity be 100 gallons, se under the required strength at the top will be the requi given quantity be more or less than 100, then mere the becomes a factor, by which multiply the given quanti number of gallons of water.——E. G. Suppose 100, at under proof: against 2 and under 14 are 14 gallons; then 50×·14=7 gallons.

er to reduce any quantity of Spirits at proof, or
proof, to any strength from 1 to 17 per cent.

NT. UNDER PROOF.									
3	9	10	11	12	13	14	15	16	17
·7	9·9	11·1	12·4	13·7	14·9	16·3	17·6	19	20·5
·6	8·8	10	11·2	12·5	13·8	15·1	16·5	18	19·6
·4	7·7	9	10·1	11·3	12·6	14	15·3	16·7	18·1
·3	6·6	7·8	9	10·2	11·4	12·8	14·1	15·5	17
·2	5·4	6·6	7·9	9·1	10·2	11·6	12·9	14·3	15·7
·1	4·3	5·4	6·8	8	9	10·4	11·7	13·1	14·5
	3·2	4·3	5·7	6·8	8	9·2	10·5	11·9	13·3
	2·1	3·2	4·6	5·6	7	8	9·3	10·7	12
	1	2·1	3·4	4·4	5·8	7	8·1	9·5	10·8
.	0	1	2·2	3·3	4·6	5·8	6·9	8·3	9·6
.	..	0	1	2·2	3·4	4·6	5·7	7·1	8·4
.	..	..	0	1·1	2·2	3·4	4·5	5·9	7·2
.	..	..	..	0	1	2·2	3·3	4·7	6
.	..	..	..	..	0	1	2·1	3·5	4·8
.	..	..	..	..	..	0	1	2·3	3·6
.	..	..	..	..	..	..	0	1·1	2·4
.	..	..	..	..	..	..	..	0	1·2
.	..	..	..	..	..	..	..	..	0

iple of Proposition 2, Case 1.

ns, seek the given strength in the margin, and
requisite number of gallons. But should the
the decimal point two places to the left, and it
uantity, and the product will be the requisite
00, at 2 per cent. under proof, be reduced to 14
ons; but if the given quantity were 50 gallons,

TABLE 3.—Shewing the Quantity of Water req

Gall. 100		18	19	20	21	22	23	24	25	26	27	2	
17	PER CENT. UNDER PROOF.	1·2	2·5	3·7	5	6·4	7·8	9·2	10·7	12·2	13·7	15·	
18		0	1·2	2·4	3·7	5·1	6·4	7·9	9·4	10·8	12·3	13·	
19		..	0	1·2	2·4	3·8	5·1	6·6	8·1	9·4	10·9	12·	
20			..	0	1·2	2·4	3·8	5·3	6·8	8·1	9·6	11·	
21		..		..	0	1·2	2·4	4·1	5·4	6·8	8·2	9·	
22			..		..	0	1·2	2·8	4·1	5·4	6·8	8·	
23		..		..		..	0	1·4	2·8	4·1	5·4	6·	
24			..		..		..	0	1·4	2·8	4·1	5·5	
25		..		..		..		..	0	1·4	2·7	4·2	
26			..		..		..		..	0	1·4	2·8	
27		..		..		..		..		..	0	1·4	
28			..		..		..		..		..	0	
29		..		..		..		..		..		..	
30			..		..		..		..		..		
31		..		..		..		..		..		..	
32			..		..		..		..		..		
33		..		..		..		..		..		..	
34			..		..		..		..		..		
35		..		..		..		..		..		..	
36			..		..		..		..		..		
37		..		..		..		..		..		..	
38			..		..		..		..		..		.
39		..		..		..		..		..		..	
40			..		..		..		..		..		.
41		..		..		..		..		..		..	
42			..		..		..		..		..		.
43		..		..		..		..		..		..	
44			..		..		..		..		..		..
45		..		..		..		..		..		..	
46			..		..		..		..		..		..
47		..		..		..		..		..		..	
48			..		..		..		..		..		..
49		..		..		..		..		..		..	
50			..		..		..		..		..		...
51		..		..		..		..		..		..	
52			..		..		..		..		..		..
53		..		..		..		..		..		..	
54			..		..		..		..		..		..
55		..		..		..		..		..		..	

isite

3	1
3	1
8	1
4	14
1	12
7	11
3	9
9	8
5	7
2	5
2	4
4	2
	1
	0

Table 3 is a continuation of Table 2, and constructed by the same *Rule.*

Its Use.—Should the given quantity be 100 gallons, find the given strength in the margin and under the required strength at the top, the figures in the angle will denote the requisite number of gallons to reduce 100 gallons from such given to such required strength.

But should the given quantity be more or less than 100 gallons, then move the decimal point two places to the left, and it becomes a factor, by which multiply the given quantity, and the product will be the requisite number of gallons of water.

E. G. Suppose 71 gallons, 33 per cent. under proof, be required to be reduced to 55 per cent. under proof.

Look for 33 in the margin, and under 55 stands 48·9; then move the decimal point two places to the left, and it will be - - - - ·489

Multiplied by 71 the given quantity,

489
3423

Produces 34·719 water required.

See this example wrought two ways on page 27.

If there be fractions in one or both the given and required strengths, take the difference between that and the next superior or inferior degree of strength, as the spirits are above or below proof, and add the proportional part of such difference to the number previously found.

E. G. Suppose 108 gallons, 05·5 per cent. over proof, be required to be reduced to 14·0 per cent. under proof.

Look in Table 1 for 100, and under 5 stands 5·, and against 8 in the same column stands 00·4; these added make 5·4; and against the same quantities, under the next superior degree of strength, stand 6·5, from which deduct 5·4, and half their difference will be ·55, added to 5·4 gives

5·95, the quantity of water requisite to reduce 108 gallons, 5·5 per cent. over proof, to proof; it will then be 108+5·95=113·95 at proof.

Then look in Table 2 for 100 gallons at proof, to be reduced to 14·0 per cent. under proof, and under 14 stands 16·3; move the decimal point two places to the left, then

113·9 at proof.
·163 the factor.

3417
6834
1139

Gives - - - 18·5657 water.
To which add - 5·95 water.

Total quantity of 24·5157 water.

See this example wrought two ways on page 22.

Suppose 80 gallons, 22·0 per cent. under proof, be required to be reduced to 42·0 per cent. under proof.

Look in Table 3 for 22 in the margin, and under 42 at the top stands 34·5; the decimal point moved two places to the left, by which multiply the given quantity thus:

·345 the factor,
Multiplied by 80 the given quantity,

Gives the requisite quantity 27·600 gallons of water.

See this example also wrought at full length on page 26.

PROPOSITION III.

When a given quantity of spirits is to be raised to a given strength, by the introduction of spirits of a higher degree of strength.

Rule. The required strength is the mean rate; find the difference between the mean rate and the strengths given.

Then, as the greater difference is to the given quantity, so is the lesser difference to the answer.

Ex. 1. Suppose 42·5 gallons to be 14·4 per cent. under proof, and it is required to raise the same to 10 per cent. under proof; what quantity of proof spirits will be sufficient to do this?

$$\begin{array}{ll} \text{Mean rate.} & \qquad\qquad\text{Difference.} \\ \text{Here } 10 \text{ U. P.} & \left\{\begin{array}{l} \text{Proof} = 10{\cdot}0 \\ \quad 14{\cdot}4 = 04{\cdot}4 \end{array}\right\} \text{ Then,} \end{array}$$

Greater difference.	Given quantity.	Lesser difference.	Required quantity.
As 10 :	42·5 : :	04·4 :	18·7 *Ans.*

Proved.

42·5×100—14·4=85·6=36·38 gallons at proof.
To which add 18·7 gallons at proof.

55·08

And 42·5+18·7=61·2×100—10=90=55·08 at proof.

Ex. 2. What quantity of spirits, 30 per cent. over proof, will be necessary to add to 140 gallons at 22·0 per cent. under proof, to raise it to 12·6 per cent. under proof?

$$\begin{array}{ll} \text{Mean rate.} & \qquad\qquad\text{Difference.}\ * \\ \text{Here } 12{\cdot}6 \text{ U. P.} & \left\{\begin{array}{l} 30{\cdot}0 \text{ O. P.} = 42{\cdot}6 \\ 22{\cdot}0 \text{ U. P.} = 09{\cdot}4 \end{array}\right\} \text{ Then,} \end{array}$$

---

* No arithmetical rule was ever before published for the solution of questions of this kind, and therefore no methodical answers thereto could be obtained, except by Algebra.

Greater difference.	Given quantity.	Lesser difference.	Quantity required.
As 42·6 :	140 : :	09·4 :	30·89 *Ans.*

Proved.

140 × 78 = 109·2 gallons at proof.

And 30·89 × 130 = 40·157 gallons at proof.

Again, 140 + 30·89 = 170·89 × 87·4 = 149·35786 proof.

And 109·2 + 40·157 = 149·357 at proof.

Ex. 3. How much spirits, 25·0 per cent. over proof, must be added to 50 gallons, 20·0 per cent. under proof, to raise it to 12·5 per cent. under proof?

Mean rate. Difference.

Here 12·5 U. P. $\left\{\begin{array}{l}25\cdot0\text{ O. P.}=37\cdot5\\ 20\cdot0\text{ U. P.}=07\cdot5\end{array}\right\}$ Then,

Greater diff.	Given quantity.	Lesser diff.	Quantity required.
As 37·5 :	50 : :	07·5 :	10 *Ans.*

Proved.

50 × 80 = 40· gallons at proof.

And 10 × 125 = 12·5 gallons at proof.

Again 50 + 10 = 60 × 87·5 = 52·5 at proof.

And 40 + 12·5 = 52·5 at proof.

Ex. 4. Suppose the preceding question were proposed thus: How much spirits at proof must be added to 50 gallons, 20·0 per cent. under proof, to raise it to 12·5 per cent. under proof?

Mean rate. Difference.

Here 12·5 U. P. $\left\{\begin{array}{l}\text{Proof}=12\cdot5\\ 20\cdot0\text{ U. P.}=07\cdot5\end{array}\right\}$ Then,

Greater diff.	Given quantity.	Lesser diff.	Quantity required.
As 12·5 :	50 : :	07·5 :	30 *Ans.*

Proved.

50×80=40 gallons at proof.
And the Answer, 30 gallons at proof.

Again, 50+30=80×87·5=70 gallons at proof.
And 40+30=70 gallons at proof.

Note. That there should be 20 gallons difference between the answers of the two preceding questions, may at first appear paradoxical, especially when it is shewn that 12·5 gallons at proof are equivalent to 10 gallons, the answer in the former case. And that 30 gallons at proof are required in the latter case, although the quantity, the given and required strengths are the same. But the paradox will be solved if it be recollected that 25·0 per cent. over proof is one-fourth of alcohol, which is absorbed in the water contained in the given quantity; and when one-fourth be deducted from 30, viz. 7·5, and added to 12·5, it will be equal to the difference between the two answers.

Previous to the introduction of Sike's Hydrometer, Clarke's Hydrometer was used for revenue purposes; and according to his system, the strength of spirits was expressed by stating the integral proportional quantities, instead of the proportion per centum, as at present.

The following simple question was proposed at Droitwich excise office, when there were about fifteen officers employed there upon the salt duties, and it produced much debate.

Ex. 5. If I have 55 gallons of rum, 1 in 5 under proof, how much proof spirits must be added to raise the strength to 1 in 6 under proof?

Here 5 : 1 :: 55 : 11 the water, and 55—11=44 at proof.
And 1 : 6 :: 11 : 66 the quantity when mixed.
Hence 66—55=11 gallons, the quantity of proof spirits required.

This question may be answered by the last rule, but not so correctly, because the proportions here given in the old form will produce indefinite recurring decimals in the form by which spirits are now designated. But any strength may be altered from the old method to the present one, by dividing 100 by the given strength.

A TABLE, shewing the equivalent strength of spirits, as designated under Clarke's system and Sike's system.

Clarke's System.		Sike's System.		
1 to 3 O. P.	Is equal to	100÷ 3=33·33		O. P.
1 .. 4 ——	....	100÷ 4=25·0		——
1 .. 5 ——	....	100÷ 5=20·0		——
1 .. 6 ——	....	100÷ 6=16·66		——
1 .. 7 ——	....	100÷ 7=14·286		——
1 .. 8 ——	....	100÷ 8=12·5	Per Centum.	——
1 .. 9 ——	....	100÷ 9=11·11		——
1 .. 10 ——	....	100÷10=10·		——
1 .. 11 ——	....	100÷11= 9·09		——
1 .. 12 ——	....	100÷12= 8·33		——
1 .. 13 ——	....	100÷13= 7·69		——
1 .. 14 ——	....	100÷14= 7·28		——
1 .. 15 ——	....	100÷15= 6·66		——
1 .. 20 ——	....	100÷20= 5·		——
1 .. 25 ——	....	100÷25= 4·		——
1 .. 30 ——	....	100÷30= 3·33		——

Any other strength, over or under proof, may be transposed by the same rule, and the above figures will answer equally the same for under proof strength, only change the characters from O. P. to U. P. Thus:

1 in 2 U. P.	Is equal to	100÷ 2=50·		U. P.
1 .. 3 ——	....	100÷ 3=33·33		——
1 .. 4 ——	....	100÷ 4=25·0		——
1 .. 5 ——	....	100÷ 5=20·0	Per Centum.	——
1 .. 6 ——	....	100÷ 6=16·66		——
1 .. 7 ——	....	100÷ 7=14·286		——
1 .. 8 ——	....	100÷ 8=12·5		——
1 .. 9 ——	....	100÷ 9=11·11		——
1 .. 10 ——	....	100÷10=10·		——
1 .. 20 ——	....	100÷20= 5·		——
1 .. 25 ——	....	100÷25= 4·		——

The preceding question, therefore, according to the method by which the strength of spirits is designated at present, will be,

If I have 55 gallons of rum, 20 per cent. under proof, how much proof spirits must be added to raise the strength to 16·66 per cent. under proof?

Mean rate.

Here 16·66 U. P. $\left\{\begin{array}{l}\text{Proof} \quad =16{\cdot}66 \\ 20{\cdot}0 \text{ U. P.}= \ 3{\cdot}34\end{array}\right\}$ Then,

	Greater diff.		Given quantity.		Lesser diff.		Required quantity.
As	16·66	:	55	: :	3·34	:	11 *Ans.*

Proved.

55 × 100—20=80=44 gallons at proof.
And 11 gallons at proof.

Again, 55+11=66 × 100—16·66=83·34=55 proof gall.
And 44+11=55 proof gall.

Some of the foregoing questions, also, may be transposed, and worked according to the old method, as for instance,

Ex. 1. Wherein the strength of 42·5 gallons, 14·4 or a little above 1 in 7, was required to be raised to 1 in 10 under proof, by the introduction of spirits at proof.

Here 7 : 1 : : 42·5 : 6·07 the water.

And 1 : 10 : : 6·07 : 60·7 quantity mixed.

Hence 60·7—42·5=18·2 the answer; but this answer is five-tenths too little.

But the question may be wrought thus:

As 1 : 42·5 : : 100—14·4=85·6=36·38 gall. at proof.

And 42·5—36·38=6·12 the water.

Then, As 1 : 10 : : 6·12 : 61·2 the true quantity.

And 61·2—42·5=18·7 the required quantity of proof spirits, as shewn on page 37.

Proved.

$$\begin{array}{rl} 42{\cdot}5 \times 100 - 14{\cdot}4 = 85{\cdot}6 = 36{\cdot}38 & \text{gallons at proof.} \\ \text{To which add } 18{\cdot}7 & \text{gallons at proof.} \\ \hline 55{\cdot}08 & \end{array}$$

Again, $42{\cdot}5 + 18{\cdot}7 = 61{\cdot}2 \times 100 - 10 = 90 = 55{\cdot}08$ at proof.
And $36{\cdot}38 + 18{\cdot}7 = 55{\cdot}08$ at proof.

The question on page 38 is transposed to the old method, and worked accordingly, as shewn below:

Ex. 4. Wherein the strength of 50 gallons, 1 in 5 under proof, is to be raised to 1 in 8 under proof, by the introduction of proof spirits.

Here 5 : 1 :: 50 : 10 the water.

And 1 : 8 :: 10 : 80 quantity mixed.

And $80 - 50 = 30$ gallons, the quantity required.

This answer is proved to be correct on page 39.

Ex. 6. What quantity of spirits, 30·0 per cent. over proof, must be mixed with 140 gallons, at 22·0 per cent. under proof, to raise it to proof?

$$\begin{array}{ccl} & \text{Mean rate.} & \text{Difference.} \\ \text{Here} & \text{Proof} & \left\{ \begin{array}{l} 30{\cdot}0 \text{ O. P.} = 30{\cdot}0 \\ 22{\cdot}0 \text{ U. P.} = 22{\cdot}0 \end{array} \right\} \text{ Then,} \end{array}$$

As 30· : 140 :: 22· : 102·66 gallons required.

$$\left. \begin{array}{l} \text{For } 102{\cdot}66 \times 130 = 133{\cdot}458 \\ \text{And } 140{\cdot} \times 78 = 109{\cdot}2 \\ \hline \text{Also } 102{\cdot}66 + 140 = 242{\cdot}658 \end{array} \right\} \text{Gallons at proof.}$$

Ex. 7. A merchant having imported 5000 gallons of spirits from Ireland, at 21·2 per cent. over proof, and he wishes to know how much of 7 per cent. over proof is it equal to?

Here 121·2×5000=606000÷107=5663·55 gallons.

Proved.

$$\begin{array}{l} \text{Gallons imported at } 21{\cdot}2 = 5000 \\ \text{Gallons equal thereto at } 7 = 5663{\cdot}55 \\ \left.\begin{array}{l} \text{For } 5000 \times 121{\cdot}2 = 6060 \\ \text{And } 5663{\cdot}55 \times 107 = 6060 \end{array}\right\} \text{at proof.} \end{array}$$

Ex. 8. A distiller would mix 50 gallons at 16 per cent. under proof, with some at 20·4 per cent. over proof, to average at proof. How much of the latter must he take?

$$\begin{array}{lll} & \text{Mean rate.} & \text{Difference.} \\ \text{Here} & \text{Proof} & \left\{\begin{array}{l} 20{\cdot}4 \text{ O. P.} = 20{\cdot}4 \\ 16{\cdot}0 \text{ U. P.} = 16{\cdot}0 \end{array}\right\} \text{ Then,} \end{array}$$

	Greater diff.		Given quantity.		Lesser diff.		Required quantity.
As	20·4	:	50	: :	16·0	:	39·2 *Ans.*

PROPOSITION IV.

When spirits of different strengths are to be compounded, and the proportional quantity of each strength is required.

Rule. Place the rate to which it is to be reduced, over that from which it is to be reduced, as a vulgar fraction; this fraction represents the due proportion of spirits, and its difference placed fractionwise, the quantity of water.

Ex. 1. Suppose 1000 gallons be required to be mixed at 7 per cent. over proof, from spirits at 21 per cent. over proof; how much water will be required?

Here $\frac{107}{121}$ of spirits, at 21 per cent. over proof.
And 21—7=$\frac{14}{121}$ the water.

As 121 : 107 : : 1000 : 884·3 gallons at 21 over proof.
And 1000—884·3=115·7 the water.

$$\overline{1000}$$

Ex. 2. Spirits at 20·2 per cent. over proof, and at 10·4 per cent. under proof, are required to make a compound at proof. Query the proportion of each?

Here $\frac{\text{Proof}}{120{\cdot}2}$ and $100-10{\cdot}4=\frac{89{\cdot}6}{120{\cdot}2}$ } Reduce these fractions by taking the difference of their numerators,

$$\text{and it will be } \frac{100-89{\cdot}6=10{\cdot}4}{\text{and } 120{\cdot}2-89{\cdot}6=30{\cdot}6} \text{ or } \frac{104}{306}\div 2=$$

$\frac{52}{153}$ proportion of the superior strength, and

$\frac{101}{153}$ of the inferior, let the quantity be great or small.

Ex. 3. Suppose the foregoing quantity were 153 gallons, it may be thus

Proved.

$$\begin{array}{l} 120{\cdot}2\times 52=62{\cdot}504;\ \text{ and } 100-10{\cdot}4=89{\cdot}6 \\ 101\times 89{\cdot}6=90{\cdot}496 \\ \hline 153{\cdot}000 \end{array}$$

Case II. *When the average is not at proof, and part of the spirits to be compounded are under proof.*

Rule. Place the strengths as before, and subtract the spirits under proof from both, setting forward the differences as numerator and denominator, and that fraction shews what is required of the superior strength, and its difference from unity shews the proportion of the feints.

Ex. 1. Suppose 1000 gallons be required at 7 per cent. over proof, part of which is to be taken from spirits 21·0 per cent. over proof, and the remainder from some at 20·0 per cent. under proof?

First, 100—20=80; then,

$$\text{Here } \frac{107}{121}-\left\{\begin{matrix}80\\80\end{matrix}\right\}=\frac{27}{41} \text{ of that at 21·0 per cent. O. P.}$$

And 41—27=$\frac{14}{41}$ of that at 20·0 per cent. U. P.

As 41 : 27 : : 1000 : 658$\frac{22}{41}$ galls. 21·0 O. P.
And 1000—658$\frac{22}{41}$=341$\frac{19}{41}$ galls. 20·0 U. P.

$$\begin{array}{l} \hline 1000 \quad \text{galls. at 7 per cent. O. P.} \end{array}$$

Ex. 2. Suppose 140 gallons, at 7 per cent. over proof, be required to be compounded from spirits at 25·0 per cent. over proof, and feints at 14·0 per cent. under proof; what quantity of each will be required?

100
14

$\frac{107}{125}$—86=$\frac{21}{39}$ the proportion of that at 25·0 O. P.
And 39—21=$\frac{18}{39}$ the proportion of the feints.

As 39 : 21 :: 140 : 75·4 gallons at 25·0 O. P.
And 140—75·4=64·6 gallons of feints.

140·0 total at 7 per cent. O. P.

Proved.

For 75·4 × 125=94·25
And 64·6 × 86=55·55

149·80 gallons at proof.

Also, 140 × 107=149·80 gallons at proof.

Note. It will generally be found more convenient and equally correct, under this rule: if there be a fraction in any one of the strengths, annex a cypher to each of the other strengths, (if any,) and work with all as whole numbers; and after finishing the operation, cut off *two* figures on the right, if no fraction, or *three*, if any fraction.

Ex. 3. Suppose 100 gallons, at 7 per cent. over proof, be required to be compounded from spirits at 25·0 per cent. over proof, 5 per cent. over proof, and feints at 20 per cent. under proof, and a double quantity to be taken of that at 5 per cent. over proof; what will be the different proportions?

Here 1000 (See preceding note.)
200

1070— 800=270
3

1250 × 1=1250
1050 × 2=2100 } =3350—2400=950
3

(=$\frac{135}{475}$ at 25·0 O. P.
$\frac{270}{475}$ at 05·0 O. P.
$\frac{70}{475}$ at 20·0 U. P.

Then, As 475 : 135 :: 100 : 28·42 galls. at 25·0 O. P.
2

56·84 galls. at 05·0 O. P.

And as 475 : 70 :: 100 : 14·73 galls. at 20·0 U. P.

Total 99·99 galls. at 07·0 O. P.

Proved.

For 28·42 × 125·0 = 35·5
56·84 × 105·0 = 59·7
14·73 × 80·0 = 11·8
107·0
} Gallons at proof.

And 107 × 100 = 107· gallons at proof.

Ex. 4. Suppose 600 gallons be required to be compounded from spirits at 30·4 per cent. over proof, 20·4 per cent. over proof, and 02·6 per cent. over proof, and feints at 40·0 per cent. under proof, and a double quantity of the strengths 20·4 and 2·6 per cent. is required, so that the average strength shall be 7 per cent. over proof; what will be the different proportions?

1000
400

1070—600= 470
5

1304 × 1 = 1304
1204 × 2 = 2408
1026 × 2 = 2052
} = 5764—3000 = 2764
5

$= \frac{235}{1382}$ at 30·4 O. P.
$\frac{470}{1382}$ at 20·4 O. P.
$\frac{470}{1382}$ at 02·6 O. P.
$\frac{207}{1382}$ at 40·0 U. P.

As 1382 : 235 :: 600 : 102·02 galls. at 30·4 O. P.
2

204·04 galls. at 20·4 O. P.
204·04 galls. at 02·6 O. P.
And as 1382 : 207 :: 600 : 89·87 galls. at 40·0 U. P.

Total 599·97 galls. at 07·0 O. P.

Proved.

$$\left.\begin{array}{rr}\text{For} & 102{\cdot}02\times130{\cdot}4=133\\ & 204{\cdot}04\times120{\cdot}4=246\\ & 204{\cdot}04\times102{\cdot}6=209\\ & 89{\cdot}87\times\ \ 60{\cdot}0=\ \ 54\\ & \overline{}\\ \text{And} & 600\ \times\ 107\ =642\end{array}\right\}\text{Gallons at proof.}$$

Ex. 5. Suppose 1868 gallons be required to be compounded from spirits at 20 per cent. over proof, 02·4 over proof, 30·6 over proof, 25·0 over proof, and some feints at 40 per cent. under proof, and a double quantity of the strengths 30·6 and 25·0 over proof, so that the average strength shall be 7 per cent. over proof; what will be the different proportions?

$$\begin{array}{c}1000\\400\\\hline 1070-600=\ 470\\6\end{array}$$

$$\left.\begin{array}{r}1200\times1=1200\\1024\times1=1024\\1306\times2=2612\\1250\times2=2500\end{array}\right\}=7336-3600=3736\ \left(\begin{array}{l}=\frac{235}{1868}\text{ at }20\quad\text{O. P.}\\ \ \ \ \frac{235}{1868}\text{ at }02{\cdot}4\ \text{O. P.}\\ \ \ \ \frac{470}{1868}\text{ at }30{\cdot}6\ \text{O. P.}\\ \ \ \ \frac{470}{1868}\text{ at }25{\cdot}0\ \text{O. P.}\\ \ \ \ \frac{458}{1868}\text{ at }40{\cdot}0\ \text{U. P.}\end{array}\right.$$

$$\begin{array}{c}\overline{\ \ }\\6\end{array}$$

In this question the required quantity is the same as the denominator of the proportional quantities; therefore proportional statements are unnecessary.

Proved.

$$\left.\begin{array}{rcrcl}1200&\times&235&=&282{\cdot}\\1024&\times&235&=&240{\cdot}64\\1306&\times&470&=&613{\cdot}82\\1250&\times&470&=&587{\cdot}5\\600&\times&\underline{458}&=&\underline{274{\cdot}8}\\107{\cdot}&\times&1868&=&1998{\cdot}76\end{array}\right\}\text{Gallons at proof.}$$

Ex. 6. Required a mixture as before, from all the over proof strengths, but take water instead of the under proof.

$$\left.\begin{array}{l}1200\times 1=1200\\ 1024\times 1=1024\\ 1306\times 2=2612\\ 1250\times 2=2500\end{array}\right\}=\frac{1070}{7336}\left(=\frac{535}{3668}\right.\text{ of the 20·0 O. P.}$$

$\frac{535}{3668}$ of the 02·4 O. P.

$\frac{1070}{3668}$ of the 30·6 O. P.

$\frac{1070}{3668}$ of the 25·0 O. P.

$\frac{458}{3668}$ water.

Note. Any quantity may be taken in the above proportions to make a compound at 7 per cent. over proof; but for the facility of proving the work, let 3668 gallons be the required quantity, and it is thus

Proved.

$$\left.\begin{array}{l}1200\times 535=642\cdot\\ 1024\times 535=547\cdot84\\ 1306\times 1070=1397\cdot42\\ 1250\times 1070=1337\cdot5\\ 0000\times 458=0000\\ \hline 107\times 3668=3924\cdot76\end{array}\right\}\text{Proof Gallons.}$$

How much spirits, 1 to 4 or 25·0 per cent. over proof, will it be necessary to mix with 468 gallons of water, to reduce it to 1 in $3\frac{3}{4}$, or 26·66 under proof.

$$\begin{array}{c}\text{Mean rate.}\\ \text{Here 26·66 U. P.}\end{array}\Big\}\begin{array}{l}\quad\text{Differences.}\\ \text{Water }=73\cdot34\\ 125\cdot0\text{ O. P.}=51\cdot66\end{array}\Big\}\text{These differences}$$

will give $\frac{73\cdot34}{125\cdot0}$ = the proportion of spirits 25·0 O. P.

and $\frac{51\cdot66}{125\cdot0}$ = the proportion of water.

Hence 51·66 : 73·34 : : 468 : 664·4 gallons, the requisite quantity at 25·0 per cent. over proof.

Proved.

For 664·4 the spirits at 1 to 4 or 25·0 per cent. O. P.
468· the water.

Total 1132·4 quantity at 1 in 3¾, or 26·66 per cent. U. P.	
73·34	And 664·4
	125
45296	
33972	33220
33972	13288
79268	6644
830·50216 proof galls.	830·500 proof galls.

The preceding question was proposed by an old officer, and was answered, though erroniously, by a very able mathematician.

He proceeded to find the requisite quantity of spirits at proof, and then took three-fourths thereof as being the true answer. Thus:

As 1 : (3¾) 3·75 :: 468 : 1755 gallons at 1 in 3¾ U. P.
And 1755—468=1287 gallons at proof.
Hence 1287÷5=257·4
And 1287—257·4=1029·6 gallons, his answer.
664·4 gallons, the true answer.

365·2 gallons too much.

It should always be observed, that when spirits over proof are to be compounded with spirits under proof, or with water, an unknown quantity of the water is absorbed by the spirits, as was explained in the note on page 39.

The preceding question by Algebra.

Let $4x$ = Spirits.
And x = Water.

$5x$ at proof.

But $\frac{5x}{2\cdot75} = 468 - x$, that is $5x = 1287 - 2\cdot75x$.

Whence $x = \frac{1287}{7\cdot75} = 166\cdot0645 \times 4 = 664\cdot258$ *Ans.*

MISCELLANEOUS QUESTIONS.

A cask whose form is the frustum of a cone, the top diameter 90 inches, the bottom diameter 48 inches, and the length 80 inches, and it is to be filled with three equal quantities; required the depth of each part.

First, complete the cone by similar triangles.

90 top diameter.
48 bottom diameter.
—
42 =their difference.

Then, as 42 : 80 :: 90 : 171·4285=Altitude of cone.

And 171·4285—80=91·4285=Altitude of the completion.

90×48×3=12960, and 90—48=42×42=1764
1764
———
14724 and 80÷3=26·666

Then 14724 × 26·666 × ·7854 = 308371·7465136 = the solidity of the cask, divided by 3 will give 102790·5821378 = the solidity of ⅓ part thereof.

And 90×90×·7854=6361·74=Area of the base.

Then 171·42÷3=57·14×6361·74=363509·8236=Solidity of the whole cone, from which 308371·7465=Solidity of the whole cask.
———
And their difference 55138·0771=Solidity of the completion of the cone.
To which add 102790·5821=⅓ of the cask.
———
157928·6592= ⅓ and the completion of the cone.

Then 171·43×171·43×171·43=5038026·823207=Cube of the altitude.

	Solidity of the whole cone.	Cube of its altitude.	Solidity of ⅓ and the comp.	
As	363509·82 :	5038026·823 ::	157928·659 :	2188795·9454

Extract the cube root of the above number.

$\sqrt[3]{2188795{\cdot}9454}=129{\cdot}83-91{\cdot}4285=38{\cdot}4015=$ Depth of the first part of the cask.

And 80 : 42 :: 38·4015 : 20·161=difference of the two lesser diameters.

And 20·161+48=68·161=Diameter of the first section.

To find the second depth,

Add 157928·6592=Solidity of ⅓ and the comp. of the cone.
102790·5821=Solidity of ⅓ of the cask.

260719·2413=Solidity of ⅔ of the cask and the comp.

Solidity of the whole cone.	Cube of its altitude.	Solidity of ⅔ and the comp.	
363509·82 :	5038026·823 ::	260719·2413 :	3613411·405035

Extract the cube root of the above number.

$\sqrt[3]{3613411{\cdot}405035}=153{\cdot}45-91{\cdot}4285=62{\cdot}0215=$ Depth of ⅔ of the cask.

And 80 : 42 :: 62·0215 : 32·56=Difference of the lesser and third diameters.

And 32·56+48=80·56 diameter of the second section, or the surface of the second quantity.

Now 62·0215—38·4015=23·62=Depth of the middle part.

And 80—62·0215=17·9785=Depth of the top part.

Proof.

Find the solidity of each part separately, by the same rule as the solidity of the cask was found; and if these be equal, and their sum equal to the whole cask, the work must be correct.

$68\cdot161\times48\times3=9815\cdot184$; and $\overline{20\cdot161}|^{2}=406\cdot465921$

And 9815·184
406·466

$$10221\cdot650\times38\cdot4=\frac{392511\cdot36}{1059}=370\cdot64$$ gallons, the content of the first part.

$80\cdot56\times68\cdot16\times3=16472\cdot9$; and $80\cdot56-68\cdot16=12\cdot4$ diff.

$12\cdot4\times12\cdot4=153\cdot76$

$16626\cdot66\times23\cdot62$=Depth of the middle,

will give $\frac{392721\cdot7092}{1059}=370\cdot8$ gallons, the content of the second part.

And $\frac{308371\cdot7465136}{277\cdot274}=1112\cdot155\div370\cdot718$ gallons, the content of the third part.

38·4015=Depth of the 1st part.
68·161 =Diameter of the section cut by the 1st quantity.
62·0215=Depth of ⅔ of the cask.
80·56 =Diameter of the section cut by the 2nd quantity.

			Gallons.	
Top -	depths	17·9785	= 370·71	Proved.
Middle		23·62	= 370·8	
Bottom		38·4015	= 370·64	
	Total	80·0000	=1112·15	

By the act of the 6 Geo. 4, chap. 80, sec. 109, no dealer in spirits is allowed to have any increase, nor any decrease not duly accounted for, exceeding 5 per centum on the balance of the last preceding account; but it is ordered, "that no notice be taken of decreases in the stocks of dealers and rectifiers, although they may exceed the ·5 per cent. provided such decreases do not exceed four gallons in any one kind of spirits." Gen. Order, 25th March, 1826.

The accuracy, therefore, required in calculating and keeping an account of the stocks of such traders, is evident; and the first thing that officers should attend to in that respect, is to get the true content of such traders' casks. But as casks are made in such a variety of figures, the general method of calculating the contents in the first variety, viz. the frustum of a spheroid differs from the truth in proportion as the cask differs from the frustum of a spheroid. And the only true method that has ever been published, is by taking a middle diameter between the bung and the head; for without a middle diameter, there are not sufficient data.

By the 123 section of the same act, every dealer in and retailer of spirits is required to mark upon every cask its full measure in gallons; and likewise to make entry thereof before it shall be made use of. The officer should also request the trader to take out the head of every new cask before it be used, that he may with greater ease and accuracy take the dimensions thereof.

CASK GAUGING.

Multiply the diameter of the head of the cask by ·707, which will give the side of an inscribed square equal thereto, and quarter the cask lengthways, and with a small string run a chalk line around the middle of the inside of the cask, parallel with the top groove; mark the midway betwixt this line and the inner surface of each head, upon the lines which quarter the cask lengthways. From these intersections take the diameters at right angles, and if there be any difference in the corresponding diameters, take their difference as the mean.

Having thus found the middle diameter between the bung and the head, take the other dimensions, or at least the head and length, in the usual way, and the content may be found by the following

RULES.

1. To the square of twice the middle diameter add the squares of the head and bung diameters; multiply the sum by one-sixth of the length, and the product divided by the circular divisor will give the content in gallons.

2. To four times the area of the middle diameter, add the areas of the bung and head diameters; multiply this sum by one-sixth of the length, and the product will be the content in gallons.

Example. Suppose the dimensions of a cask be, head diameter 26·0, middle diameter 30·7, bung diameter 33·2, and the length 43·8; the content by the second of the above rules will be

Middle diam.	Area in gallons.	
30·7 =	2·6696	
	4	
	10·6784	
26·0 =	1·9148	=Head diameter.
33·2 =	3·1221	=Bung diameter.
	15·7153	Multiplied by ⅙ of the length.
43·8÷6 =	7·3	
	471459	
	1100071	
	114·72169	the content.

Take the same dimensions, and calculate the content in the usual manner, and it will be

33·2—26·0=7·2×·7=5·04+26=31×31=961

And 961×43·8=42091·8÷353=119 gallons.
Whence deduct 115 the nearest gallon.

4 the difference.

That is, the content would be four gallons too much by the usual method of cask gauging.

For a check against the accuracy of the officer's calculations, and to comply with the requisitions of the law, every dealer in and retailer of spirits, would do well, on the introduction of any new cask, to fill the same with water, and measure the water very carefully with any correct measure, either on filling or on emptying the cask, and take the dip or wet inches every canful; he may thus find the content of the cask, and also form a very useful table, shewing the quantity contained in the cask at every dip which he has taken.

The middle diameter may be found by boring a hole, or by taking the circumference at one-fourth part of the perpendicular length of the cask.

Now in the cask before specified, the circumference was found to be 101·5 inches.

Whence, as 22 : 7 :: 101·5 : 32·3 the outside diameter, and the thickness of the staves was about 0·8 inch.

Then $32{\cdot}3-0{\cdot}8\times2=32{\cdot}3-1{\cdot}6=30{\cdot}7$ the middle diameter.

It must be allowed, however, that many objections may be made against taking the circumference of a cask in order to find the diameter.

1st, If the cask be round, and the staves of equal thickness, it may be found correctly; but,

2nd, If the cask be round, and the staves not of an equal thickness, the circumference will be two much.

3rd, If the cask be not round, although the staves be of an equal thickness, the circumference will be too much.

Lastly, in proportion as the cask differs from a circle, so will the circumference be too much. For it is well known, that of all figures, the circle contains the greatest space within the least circumference. Hence it is manifest that the diameter found from taking the circumference can never be too little, except when taken in an improper place, or an improper allowance be made for the thickness of the staves.

OF CONCENTRATION.

It has been discovered by experiment, that if any cask or other vessel capable of containing any quantity, suppose for example 120 gallons, and that if 100 gallons of spirits, and 20 gallons of water, be put therein, such quantities will not fill the said cask; from which it follows that either a proportion of the water must be absorbed by the spirits, or the spirits by the water.

But it is also known from experiment, that a proportion of water is always absorbed by the spirits, and hence that quantity so absorbed is called the concentration.

To find the quantity of water which any quantity of spirits at any given strength will admit in the concentration.

Rule. Multiply the given strength of the spirits by ·0000875, and that product multiplied by the quantity, will shew the concentration very nearly, when the temperature is about 52 degrees.

A rectifier compounded 100 gallons of spirits, at 20 per cent. over proof, with 20 gallons of water; this he put into a cask, containing just 120 gallons, yet he finds the cask is not full; what quantity of water will fill it up?

Here ·0000875
120=20 per cent. O. P.
0·0105000
100 gallons of spirits.
Gallons 1·0500000=the concentration.

Hence we find that 100 gallons of spirits,
And $\left\{\begin{array}{l}20\\ \;1{\cdot}05\end{array}\right\}$ Gallons of water,
Are gallons 121·05=the quantity to fill a cask of
120· gallons.
1·05=the concentration.

N. B. In cold weather, when the temperature is low, spirits will condense and appear stronger; and in warm weather, or when the temperature is high, they will expand and appear weaker.

ADDENDA.

CHARGES UPON MALT FLOORS.

(7 and 8 Geo. 4, chap. 52, sec. 42.)

To ascertain whether a floor gauge of malt taken before the expiration of 72 hours, or a subsequent gauge upon the same steeping after 96 hours, be the charge.

RULE. Multiply the amount of the gauge taken before the expiration of 72 hours, by 1·333; and if it exceed any subsequent gauge, it is the charge; but if it be less, then the latter is the charge.

Or multiply any gauge taken after the expiration of 96 hours by ·75, and compare them as above directed.

Or say, as 3 is to 4, so is the amount of the former to any subsequent gauge.

EXAMPLE. Suppose a couch gauge be 73·5, and a floor gauge be taken upon the same steeping before the expiration of 72 hours, which amounts to 90·4, and a subsequent gauge was taken on the same amounting to 118 bushels; which of these is the charge?

Here $73·5 \times 1·2 = 88·2$, therefore 90·4 is the best.

Then $118· \times ·75 = 88·5$, therefore 90·4 is the best.

Or $90·4 \times 1·333 = 120·5$, therefore 90·4 is the best.

Or as 3 : 4 :: 90·4 : 120·53, as above; therefore 118 is not equal to 90·4.

Another gauge was taken upon the same steeping, amounting to 121 bushels. And by the second and third methods shewn above, this will be a better gauge than either of the former, and will therefore be the charge.

The former of the above factors is found by dividing 200 by 150, or dividing 1·6 by 1·2; and the latter is found by dividing the same numbers contrarywise.

FINIS.

T. Eaton, Printer, Worcester.